Opportunities and Constraints for Ethanol-Based Transportation Fuels

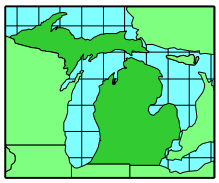
Prepared by:

Michigan Biomass Energy Program
Kelly Launder, Program Coordinator

Discussion Paper
September, 1999

Opportunities and Constraints for Ethanol-Based Transportation Fuels

A Report of the
Michigan Biomass Energy Program



The goal of the Michigan Biomass Energy Program (MBEP) is to encourage increased production and/or use of energy derived from biomass resources through program policies, information dissemination, and state and regionally funded research and demonstration projects.

Contact Information:

For additional copies of this report or more information concerning biomass energy in Michigan contact the MBEP at:

Department of Consumer and Industry Services
Energy Resources Division
Michigan Biomass Energy Program
6545 Mercantile Way, Suite #9
Lansing, MI 48911

Phone: (517) 334-6261
Website: http://ermisweb.state.mi.us/biomass

Preparation of the Report:

Kelly Launder-principal writer, editor, researcher
Jones Govereh-researcher, writer
Jan Patrick-program manager, Section Supervisor

Acknowledgments:

The MBEP staff would like to thank the following agencies and organizations, as well as many individuals not listed, who provided valuable information, comments, and suggestions for this report.
Michigan Departments of Agriculture, Consumer & Industry Services, and Management & Budget
U.S. General Services Administration
National and Michigan Corn Growers Association
Ford Motor Company and Daimler-Chrysler Corporation

We would also like to acknowledge the U.S. Department of Energy and the Great Lakes Regional Biomass Energy Program whose financial assistance supports the operation of the MBEP and the publication of reports such as this.

Table of Contents

Introduction

Ethanol is an alcohol fuel made through the fermentation of plant sugars from agricultural crops and biomass resources.[1] The most common agricultural crop utilized for ethanol production is corn, but other crops such as wheat, and milo are also used (see Figure 1, for process[2]). Only a portion of the feedstock is needed for ethanol production. The remainder can be used for animal feed, corn oil or other products.

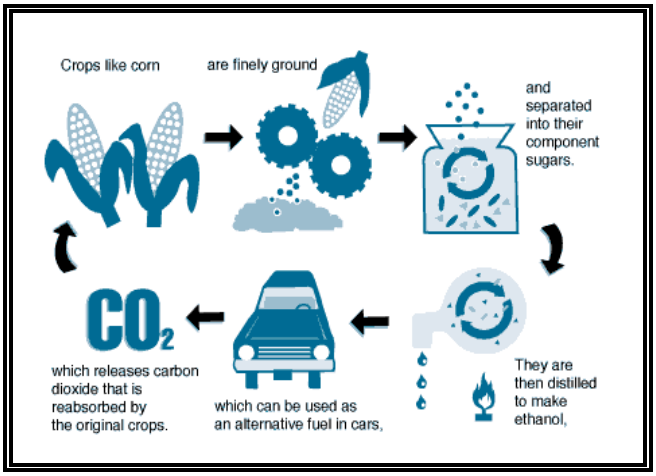


Figure 1: Ethanol Cycle (using Agricultural Crops)

Biomass resources that can be used for ethanol production include: paper mill sludge, municipal solid waste, sawdust, sugar beet pulp, cheese whey, and rice straw. Using biomass resources to produce ethanol not only utilizes waste, it also provides a value added market which increases both farmers and industrys profits.

Because ethanol is produced from agricultural crops and biomass resources it is one of the few transportation fuels that is both a renewable energy resource and domestically produced. Being domestically produced, ethanol's broader use can decrease U.S. dependency on foreign oil and retain more dollars in the local community. Currently, the U.S. imports over 50% of our transportation fuel and if the trend continues, we will import up to 75% by 2020. The costs for such a heavy reliance on foreign oil are significant. The U.S. Department of Energy (DOE) estimates military costs for energy security to be $35 billion per year. An additional $300 million per year is spent to maintain the Strategic Petroleum Reserve to provide oil during supply disruptions, such as the 1973 Oil Embargo and the Persian Gulf war.[3]

Demand for ethanol in the U.S. has increased somewhat during the past two decades due to its use in gasoline as an octane enhancer and the more recent use of E-85 (85% ethanol blended with 15% gasoline) in ethanol compatible vehicles. The increase in the manufacturing of E-85 vehicles is largely due to federal alternative fuel vehicle (AFV) purchasing mandates. Under the Energy Policy Act (EPAct) of 1992, both government and utility/fuel provider fleets are required to purchase AFVs as part of any new vehicle purchases. For 1999, the proportion of new vehicle purchases that must be AFVs are: 75% for federal fleets, 25% for state government fleets, and 70% for utility/fuel provider fleets. In 2001, 75% of new vehicle purchases by the government and 90% of purchases by utility/fuel provider's must be AFVs. The mandates apply to fleets of 20 or more vehicles, in metropolitan areas with a population of 250,000 or more. In Michigan, 25 counties in the lower peninsula are covered by AFV purchase mandates. The mandates could also apply to municipal and private fleets starting in 2002. If the DOE issues a final

rule implementing the AFV purchasing requirements for municipal and private fleets 20% of new vehicle purchases in 2002 would have to be AFVs, 40% in 2003 and 70% by 2006.[4]

Currently, 143 E-85 vehicles are being operated by federal fleets in Michigan, and 87 are operated by the state fleet. The state anticipates purchasing 245 additional E-85 vehicles in 1999, 315 in 2000, and expect to have a total of 4,397 by 2005.[5] In addition to the federal, state, and utility fleets, other fleets not mandated to purchase AFVs are also operating E-85 vehicles. Michigan State University, for example operates 22 E-85 cars. However, the majority of E-85 vehicles in Michigan have been purchased by private citizens. As of January, 1998, 8,500 passenger vehicles equipped to run on E-85 had been purchased and registered with Michigan Secretary of State.[6]

With more vehicles that are optimized for E-85 fuel use on Michigan roads, there is an impetus for expanding the E-85 refueling infrastructure. Currently, only two public refueling sites exist -one in downtown Lansing and the other in southwest Detroit. The lack of refueling sites along major corridors and throughout the state means that most ethanol compatible vehicles run exclusively on gasoline, as they can run on either gas or ethanol blended fuel.

A current focus of the Michigan Biomass Energy Program (MBEP) is to assess the ethanol supply and demand situation in Michigan. This includes identifying the opportunities and barriers for additional ethanol refueling sites in Michigan. As the MBEP began to research these issues, staff discovered that there was a lack of comprehensive resources on ethanol. It was therefore decided to publish and distribute this paper. MBEP staff intends for the information contained in this paper and ideas generated from it, to assist others in pinpointing areas where government and private interests can work together to facilitate more sustainable economic growth through the expanded use of renewable transportation fuels such as ethanol.

This paper begins with a brief history of ethanol, shown through a timeline of significant ethanol related-events. The following sections include a discussion of various ethanol blends/markets, an overview of ethanol production in the U.S., ethanol's environmental impacts, and key ethanol stakeholders. Within each section Michigan specific information is provided. The paper concludes with a summary of ethanol consumption and potential for production in Michigan, and recommendations for state government's role in assisting ethanol development.

Timeline of Ethanol-Related Events

☞late **1850's**
-Approximately 90 million gallons of ethanol is produced in the U.S.[7]

☞**1908**
-Henry Ford designed the Model T to run on ethanol.

☞During WWI ethanol is used as a fuel and in the manufacturing of gunpowder and weapons.

☞**1919**
-Due to Prohibition ethanol can only be sold in its denatured form (usually denatured by adding petroleum).

☞**1920**
-Standard Oil Co. started selling ethanol blended gasoline that contained 25% ethanol in the Baltimore area. This was discontinued in 1924 due to high corn prices and problems with storing and transporting the ethanol.[8]

☞**1930's**
-End of Prohibition
-First ethanol plant since Prohibition becomes operational [9]

☞early **1940's**
-During WWII about 600 million gallons of ethanol was produced annually in the U.S. At the end of WWII demand for ethanol dwindled and continued to decline for the next two decades, mostly due to cheap petroleum imports. [10]

☞**1973**
-The oil embargo against the U.S. by Arab countries created petroleum shortages which resulted in large price increases for gasoline and long lines at gas stations. This raised concern about our dependency on imported petroleum products and created a push for energy conservation and the development of alternative fuels.

☞**1977**
-Gasohol is introduced as a fuel extender.[11]

☞**1978**

-*Energy Tax Act*
This Act exempted ethanol blended fuel (with at least 10% ethanol) from the 4¢/gal. federal excise tax imposed on motor fuels, which gave ethanol a tax exemption of 40¢ per gallon. The Act also provided a 10% investment tax credit for ethanol production facilities.[12]

☞**1980**

-*Energy Security Act*
Due to the 1980 invasion of Afghanistan by the Soviets, grain exports to USSR were halted, which threatened domestic corn production. This act was passed to provide more than $1 billion in loan guarantee funding for ethanol production to increase the utilization of corn.[13]
-*Crude Oil Windfall Profit Tax Act*
Extended the 4¢/gal. tax exemption for E-10 (gasohol) to December, 1992 and

established a blender's credit of 40¢ per gallon, for the blending of ethanol and gasoline.
-*Omnibus Reconciliation Tax Act*
Instituted a tariff which priced imported ethanol above the U.S. market price range to protect domestic ethanol producers from cheap, Brazilian ethanol.[14]

☞**1980**
-Chrysler, Ford, and General Motors now cover the use of ethanol blends of up to 10% in their vehicle warranties.[15]
-Production of ethanol doubles from 20 million gallons to 40 million gallons.[16]

☞**1983**
-Most auto companies have approved the use of gasohol in their vehicles.
-Michigan is the largest consumer of gasohol in the U.S., using approximately 570 million gallons.[17]

☞**1984**

-*Tax Reform Act*
Increased the tax exemption for E-10 to 6¢ per gallon and the ethanol blender's tax credit to 60¢ per gallon.[18]

☞**1986**
-Ford introduces its first E-85 flexible fuel demonstration vehicle
-U.S. production of ethanol has increased to 750 million gallons

☞**1987-88**
-drought in the Midwest

This caused corn prices to rise and threatened to reduce ethanol producer and blender profit margins. To offset the high corn prices, government corn stocks were sold to ethanol producers at a lower cost.[19]

☞**1990**

-*Clean Air Act amendments*
Mandate the use of reformulated gasoline in areas with severe ozone pollution and oxygenated fuels during winter months, in areas with high carbon monoxide pollution. Alcohols, such as ethanol, are designated as the fuels to be used in reformulated and oxygenated gasoline.[20]
-*Omnibus Budget Reconciliation Act*
This Act reduced the tax exemption for E-10 to 5.4¢ per gallon, the blender's tax credit from 60¢ to 54¢ per gallon and maintained the 6¢ per gallon tax exemption for E-85 and extended them to the year 2000.[21]
-U.S. Department of Energy encourages increased ethanol production to replace oil imports after the invasion of Kuwait by Iraq.
-Chrysler and General Motors recommend the use of ethanol blended fuels in their new warranty statements.[22]

☞**1992**

-*Energy Policy Act*
This Act mandated the purchase of alternative fueled vehicles in government and private fleets and established a goal of 30% replacement of petroleum fuels by 2010.[23] The E-10 excise tax exemption was expanded to include ethanol-blended fuel of less than 10% blends. Congress also provided tax breaks for E-85 (fuel tax is 2.5¢ for E-85 vs.15¢ for gasoline).

☞**1993**

-State of Michigan purchased 10 ethanol flexible fuel vehicles and collected data on emissions and operating performance. An E-85 fuel tank was also installed at the State Secondary Complex to refuel the vehicles.

☞**1994**

-EPA proposes a rule mandating that renewable fuels (such as ethanol) be used in 30% of the reformulated gasoline. The American Petroleum Institute and the National Petroleum Refiners Association successfully challenge the rule in court.
-12% of gas sold in the U.S. is blended with ethanol.[24]

☞**1995**

-Nearly all car manufacturers recommend the use of ethanol blends up to 10%.[25]
-Ethanol production is at an all time high, and more than 1.5 billion gallons of ethanol is produced[26]

☞**1996**

-Ford begins production of E-85 capatible Taurus's, which become the best selling AFV in the U.S.[27]

☞**1997**

-First public E-85 refueling station in Michigan is established in Detroit.
-Chrysler manufactures E-85 capatible 1998 Dodge Caravan, Plymouth Voyager and Chrysler Town and Country minivans.

☞**1998**

-5.4¢ federal ethanol tax exemption was extended to 2007.[28]

-Ford manufactures approximately 90,000 E-85 capatible Ranger pickup trucks.

-Second public E85 refueling station in Michigan is established in downtown Lansing.
-First National Ethanol Vehicle Challenge. 14 schools received a GM Malibu to modify to run on E-85. Vehicles were judged at the GM proving grounds in Milford, Michigan then traveled to Washington D.C. and displayed on Capitol Hill.

Wayne State University won first place and Kettering University (shown above) won "Best Engine-Out Emissions.

☞**1999**

-Second National Ethanol Vehicle Challenge. 14 schools received a GM Silverado truck to modify to run on E-85. Kettering University won third place and "Best Off-Road Handling" and Wayne State University won fifth place and lowest emissions.

Ethanol Markets

From before the Civil War until 1861 when kerosene came on the market, ethanol was one of the most popular lamp illuminants. Once kerosene was introduced it quickly replaced ethanol for that use as it was much cheaper. Because of the $2.08/gallon alcohol tax imposed on ethanol it was priced out of the market until 1906 when the tax was lifted. After the tax was lifted ethanol use increased until Prohibition in 1919, when it could only be sold if it was denatured, usually with petroleum. After Prohibition ended, ethanol rebounded once again when it was used during WWII for fuel and to make synthetic rubber. However, when WWII ended ethanol wouldn't be used on a large scale until the 1980's when it began to be used as an fuel extender.[29] Ethanol can be used in any combination of blends up to 10% without any vehicle modifications. Higher blends must be used in modified vehicles.

Oxygenated and Reformulated Fuels

Ethanol blends can be used to meet both oxygenated and reformulated gasoline requirements in non-attainment areas for carbon monoxide and ozone. To meet oxygenated fuels standards a blend of at least 7.3% ethanol is required. To meet reformulated gasoline requirements a blend of at least 5.4% ethanol is needed. The EPA has stated that ethanol is "the second most common fuel oxygenate [and] is used in about 15% of the oxygenated fuels". [30]

Ethanol is being encouraged by some as a replacement for MTBE, currently the most commonly used oxygenate, due to water contamination and health concerns that have been reported. Unlike Ethanol, MTBE is highly soluble in water and travels easily and swiftly to ground and surface water supplies. Problems with MTBE first surfaced in Alaska where it was blamed for up to 500 complaints of headaches, chronic and severe dry skin, and burning in eyes and lungs. Several hundred residents in New Jersey complained of similar problems. Additional reports of these types of health problems due to MTBE came from Pennsylvania, Montana, Arizona, and other states. Even the American Petroleum Institute (API) has issued warnings on health problems associated with methanol. The Vice President of the API was quoted in the Oil and Gas Journal as saying that "even small amounts of methanol either ingested or absorbed through the skin can cause blindness, permanent neurological damage, and death".[31] Maine has opted out of the reformulated gasoline program due to reported problems with MTBE contamination in water supplies. A study by Maine's Department of Human Services and Environmental Protection found that "...detectable levels of MTBE [were found] in...15% of the wells and public water supplies". The study also concluded that more than 1,000 of wells in Maine may be "contaminated above [the] health threshold" and that MTBE's "...mobility and persistence in groundwater is...causing its detection far more frequently than any other constituent of gasoline".[32] The potential health hazzards from use of MTBE is also documented in a recent report from the University of California-Davis titled "*Health & Environmental Assessment of MTBE*" which concluded that "there are significant risks

and costs associated with water contamination due to the use of MTBE". Researchers also found MTBE in over 10,000 groundwater sites in California. The report supports the use of ethanol in place of MTBE stating, "the use of...ethanol as an oxygenate...would result in much lower risk to water supplies, lower water treatment costs in the event of a spill, and lower monitoring costs".[33] At the end of July, 1999 an EPA advisory panel also concluded that MTBE was a threat to drinking water and recommended that it's use be "reduced substantially".[34] In reaction to these findings, a bill has been introduced in California to phase out the use of MTBE in gasoline by the end of 2002 and the U.S. Senate recently passed a resolution supporting a nationwide phase-out of MTBE and the use of ethanol in its place.[35]

Ethanol 10/Gasohol

Alcohol blended fuels (gasohol and gasoline blended with methanol) have been used on a large scale since the late 70's. However, due to the absence of motor fuel standards in the 80's when alcohol blended fuels were first being widely distributed, there were many incidents of mis-blended gasoline. Consequently, there were numerous consumer complaints about vehicle damage. In 1983 the EPA concluded that, "of 250 samples of unleaded gasoline, [from 150 Detroit stations] 20 had illegal amounts of methanol and 45 had illegal amounts of ethanol. Shortly after this analysis took place Chrysler sent statements to dealers that mis-blended gasohol and gasoline with methanol could result in corrosion and deterioration of certain vehicle materials and parts, and/or fuel separation which will cause the engine to stop. Additionally, 2/3 of vehicle manufacturers threatened to void warranties if methanol was used in their vehicles. Most manufacturers allowed the use of ethanol blends yet "Honda, Renault, and Toyota said that 10% ethanol blends [could] be used at the owner's risk".[36] As a result of these initial problems 12 states (including Michigan) adopted alcohol blended fuel standards and required pump labels identifying gasoline containing alcohol.

All car manufacturers have now approved the use of ethanol blends of 10% or less for all of their vehicles and some even recommend the use of ethanol. General Motors Automobile Warranty for example, state that, "General Motors recommends use of oxygenated fuels such as... ethanol in gasoline".[37]

The Ethanol Producers and Consumers organization recently stated that "over 12% of gasoline sales in the U.S. are a blend of 10% ethanol...".[38]

In Michigan

A motor fuel tax exemption was established in Michigan from 1980 to 1984 (and later extended to 1986) for gasohol. The tax exemption decreased over the six year period from 5¢ to 1¢ per gallon. State and federal tax exemptions totaled 9¢ per gallon which made gasohol cheaper then regular unleaded gasoline. Consumption of E-10 in Michigan increased from 29.3 million gallons in 1980, to 566 million gallons in 1983, making Michigan the highest consumer of gasohol in the United States.[39]

Since 1994, use of E-10 in Michigan has sharply decreased. Demand for E-10 in 1997 was less than half of that in 1994.[40] When the labeling laws were proposed it was argued by four Michigan State departments in a report, Alcohol Fuels in Michigan, that "motorists will be confused by the labeling requirements..." and "it is likely that gasohol

sales would decline if Michigan adopted a labeling law". The report also refers to studies by Atlantic Richfield which found that, "when consumers are aware that the unleaded [gasoline] is in fact gasohol they tend to shun the product".[41] It is argued by some that, as predicted, labeling requirements have resulted in lower gasohol sales, and that either labels should be removed, all additives should be labeled/made public, and/or an intense education campaign should be launched to counteract the negative stereotype of gasohol that was acquired in the early 80's.

Ethanol 85

E-85 is a blend of 85% ethanol and 15% gasoline. E-85 compatible vehicles have special hoses, valves, fuel lines, and fuel tanks that resist alcohol corrosion. The vehicles also have a fuel sensor to detect the amount of ethanol in the fuel tank and a larger tank to compensate for the decrease in range.[42] The automobile companies started producing E-85 compatible vehicles in 1996 and Chrysler alone has produced approximately 153,000 to date and expects to manufacture another 150,000 in 1999.[43] All recently manufactured E-85 vehicles can run on E-85, gasoline, or any combination of both.

One setback is the limited lines and model types of vehicles being produced by the auto manufacturers. On-going research and development programs have kept automakers from working on more than a few different model types.[44]

Although the production of E-85 compatible vehicles has greatly increased, the lack of an adequate refueling infrastructure leaves many E-85 vehicles being fueled solely with gasoline. Fuel availability was cited by both federal and state fleet operators as a main consideration in purchasing alternative fueled vehicles.[45]

A range of about 50-100 E-85 vehicles is necessary to successfully support a refueling station.[46] Without targeting state and federal E-85 vehicle assignments to specific areas, it is difficult to raise the concentration of vehicles to a level where it can support a refueling station in the short term.

However, the siting of E-85 stations need not be based only on the location of the number of E-85 vehicles in the immediate area. The number of vehicles passing by a particular route should also be taken into consideration and refueling facilities could be established along major transport corridors between metropolitan areas. Federal fleet vehicles in Detroit for example, may travel to Lansing, Grand Rapids or across the state to Chicago, requiring refueling facilities along the I-94 and I-96 corridors.

Besides the lack of refueling infrastructure, the penetration of ethanol in the gasoline market has also been hampered due to the inability to transport ethanol via petroleum pipelines. A report to the Chairman of the Committee on Ways and Means, states that "most petroleum pipelines will not carry ethanol because the ethanol can suffer water contamination or cross contamination with other petroleum products, and because of ethanol's corrosive properties".[47] Therefore ethanol has to be transported by truck or railroad to a blender or distributor to be mixed with gasoline. This increases the price of ethanol as pipelines are much cheaper sources of transportation. In fact shipping fuel by pipelines is 25 times cheaper than shipping it by truck.[48]

E-85 in Michigan

Currently, Michigan has only two public E-85 refueling sites, one in Lansing and one in Detroit. The facilities, which were established with support from the National Ethanol Vehicle Coalition (NEVC) and Corn Marketing Program (CMP), have been operational since March, 1998. The Detroit Mobil facility cost the CMP about $52,000. This covered purchase and installation of equipment and application for permits. The Mobil facility in Lansing cost approximately $9,000, for the purchase and installation of the pump. The relatively low cost was due to CMP not having to purchase a tank, as an already existing empty tank was utilized. These investments are made in the form of a forgivable loan from the NEVC.

Ethanol Markets Summary

Because ETBE, E-10, and any blend of ethanol under 10% can be used without vehicle modification and distributed through the existing infrastructure, increasing the use of these blends can be done more expediently and with little or no incremental expense. This may be accomplished through policy initiatives, public education and promotion.

If state and federal government agencies continue to increase the amount of E-85 vehicles acquisitions and target vehicle assignments to specific areas, a sufficient demand will be created to establish additional public refueling sites. Then the focus can shift to establishing public E-85 refueling stations along major corridors to service both fleet vehicles as well and private citizens.

As demand for all these blends of ethanol increases it will support both new and existing ethanol production facilities.

Ethanol Production

The production of ethanol was on a steady rise in the 80's, peaking in 1995. However, high corn prices at the end of 1995 and into 1996 greatly increased the cost of ethanol while oil prices fell, making it hard for ethanol to compete with gasoline. Consequently, ethanol demand and production dropped. Since 1996 production has been steadily increasing again, with a large increase in mid-1997 and record-breaking production in October, 1998, reaching 103,000 barrels/day. [49] Total production in 1998 was over 1.36 billion gallons.[50] As of September, 1999 there were 58 ethanol plants operating or under construction in 22 states in the U.S. (see Figure 2).[51]

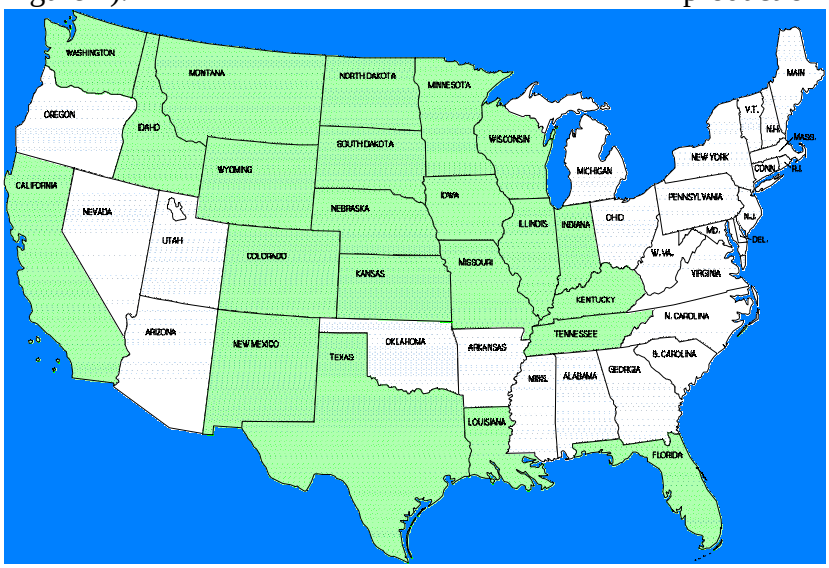


Figure 2: States with ethanol plants (shown in green)

Production and employment

An increase in ethanol plants means a considerable increase in jobs. "The U.S. Department of Agriculture estimates that a 100 million gallon ethanol plant could create 2,250 local jobs for a community."[52] More than 195,000 jobs have already been created due to the ethanol industry.[53] A study by the National Corn Growers Assoc. found that, "expansion of the ethanol industry [from]..1992 [thru] 2000 could create over 273,000 jobs".[54]

Economic Activity and Incentives

Ethanol production adds value to agricultural crops and retains more of the profits in the local community. The Corn Marketing Program estimates that, "nearly 80% of the money generated by an ethanol plant is spent within a 50 mile radius of the factory."[55]

Due to the rise in ethanol demand and production in 1997, there was an increase of more than $3.6 billion in Federal tax revenues and over $450 million in additional state tax receipts (for all states combined). There was also $11.6 million in additional Michigan tax receipts from ethanol related economic activity. It can therefore be concluded that the overall economic impact of ethanol justifies the federal tax incentive which cost $0.6 billion in 1997.[56] The RFA stated that new technological developments along with the extension on the tax incentive till 2007 is responsible for the increase in ethanol production and facilities. Since the tax incentive was extended three new plants have opened and several more plants are under construction and scheduled to begin production in 1999.[57]

State tax incentives have also played an important role in stimulating ethanol production. A 1997 report to the U.S. House of Representatives by the General Accounting Office states, "the economic viability of the ethanol industry depends on the size of state subsidies as well as the federal incentives" and that the "state tax incentives combined with the federal exemption of 54¢ per gallon, allow ethanol to compete profitably with substitute fuels". State production and blender credits range from 20¢ to 40¢ per gallon of ethanol and tax exemptions range from 10¢ to 80¢ per gallon.[58]

Factors for in-state production

It can be inferred from Table 1 (page 13) that state-based ethanol incentives, corn production, air-quality status, and ethanol consumption may all contribute to in-state ethanol production.

The top 5 states for corn production (IA, IL, NE, MN, IN) are also the top 5 states for ethanol production and all but one of the states (IN) has some type of fuel incentive. Ethanol production is more important to these states due to the value-added market for corn and increased profitability from ethanol production. Although Indiana does not offer any type of fuel incentive and ranks 5th in ethanol production, it also has only one ethanol production plant (compared to the others which have at least 5) and produces less than ½ the amount that Minnesota does (which is ranked 4th in production). To further support the argument that state incentives may indeed lead to in-state ethanol production, only 2 out of 12 states which offer ethanol fuel incentives don't have ethanol production (CT and OH). One explanation for why Ohio doesn't have in-state ethanol production although the state offers incentives, is their proximity to states with high ethanol production (IN and IL), which makes it easy to import ethanol rather than produce it themselves. An explanation for why Connecticut has incentives but no ethanol production is their relatively low ethanol sales, with only 2.6% of the total gasoline sales including ethanol.

Another interesting similarity is that all the states with non-attainment areas for Carbon Monoxide (CO) or Ozone air quality standards use ethanol. In ten of the fifteen states with non-attainment areas, ethanol makes up 5-45% of the states total gasoline sales. This would indicate that states are recognizing ethanol's abilities to reduce CO and Ozone emissions. Twelve out of the fifteen states with non- attainment areas also have ethanol production. Additionally, all but one of the states which participate in the Oxygenated (Oxy) fuel program and/or Reformulated Gasoline (RFG) program, due to CO or Ozone non-attainment status, have ethanol production plants. In most cases, plants are placed in or near the areas which are required to use reformulated or oxygenated gasoline. In fact, in 7 of the 9 states, ethanol plants are in the vicinity of the areas which participate in the Oxy fuel or RFG program.

There also appears to be a relationship between state ethanol consumption and in-state ethanol production. All states, except Ohio, with ethanol blends making up over 5% of their total gasoline sales, have ethanol plants. Again, Ohio may be an exception due to the state being next to the top ethanol producing states, so they can easily import all of their ethanol.

Table 1. Incentives, Air Quality Status, Corn & Ethanol Production, and Use of Ethanol by State

State	Ethanol Fuel Incentives [59]	CO non-attainment (SA) / Oxy fuel prog. [60]	Ozone non-attainment (SA) / RFG prog. [61]	1997 Corn Production Ranking [62]	*Plants/ Capacity (MGY) [63]	Ethanol % of gas sales [64]
California (CA)		Yes /	Yes / Yes- SA	23rd	2 / 6.7	13
Colorado (CO)		Yes / Yes-SA		13th	1 / 1.5	45
Connecticut (CT)	Tax exemption	Yes / Opt-in	Yes / Opt-in	NA	0 / 0	2.6
Florida (FL)			Opt-in /	36th	1 / 5	.13
Idaho (ID)	Tax exemption			37th	2 / 8.0	NA
Illinois (IL)	Tax exemption Blender credit		Yes / Yes-SA	2nd	5 / 725	30
Indiana (IN)		Yes /	Yes / Yes-SA	5th	1 / 88	17
Iowa (IA)	Tax exemption			1st	5 / over 337.5	34
Kansas (KS)	Producer credit		Opt-in /	8th	4 / 31.7	2
Kentucky (KY)	Tax exemption		Yes / Yes-SA	14th	1 / 6.0	3
Louisiana (LA)			Opt-in /	20th	1 / 20	1
Michigan (MI)		Yes /	Opt-in /	11th	0 / 0	5
Minnesota (MN)	Tax exemption Producer credit	Yes / Yes	Yes /	4th	15 /over 178.7	67
Missouri (MO)	Blender/prod. credit		Opt-in /	10th	1 / 15	4.6
Montana (MT)	Producer credit	Yes / Yes-SA		41st	1 / NA	NA
Nebraska (NE)	Producer credit			3rd	6 / 228	23
N. Dakota (ND)				19th	2 / over 12	1
New Mexico (NM)		Yes /		32nd	1 / NA	22
Ohio (OH)	Blender credit	Yes /	Opt-in /	6th	0 / 0	19
S. Dakota (SD)	Tax exemption Blender/prod. credit			9th	3 / 16	37
Tennessee (TN)		Yes /	Opt-in /	18th	1 / 45	.1
Texas (TX)		Yes / Yes-SA	Yes / Yes-SA	12th	1 / 1.2	2
Washington (WA)		Yes /	Yes	30th	2 / 8.2	7
Wisconsin			Yes / Yes-SA	7th	1 / 3	26
Wyoming				35th	1 / 4	6

***** Number of plants includes plant still under construction
MGY Million Gallons per Year
NA information not available
Opt-in State is participating on a voluntary basis
SA Selected areas in the state
Note: Areas participating in the Oxygenated (Oxy) fuel program sell oxygenated gasoline during winter months
Areas participating in the Reformulated Gasoline (RFG) Program sell RFG year-round

Production from Corn

Currently, the majority of ethanol is produced from corn. One bushel of corn produces 2.7 gallons of ethanol. The byproducts from ethanol production, can still be used for other products such as animal feed and corn oil.[65] According to the Renewable Fuels Association, "the production of ethanol does not mean less corn available for food" it "actually produces

many valuable high protein food and feed co-products". For example, "an acre of corn...produces 313 gallons of ethanol, 1,362 pounds of...protein feed for livestock, 325 pounds of 60% gluten meal, and 189 pounds of corn oil.[66] The U.S. ethanol industry consumes 560 million bushels of corn and boosts the price of corn by 8-10¢ per bushel. When translated to income, this represents additional earnings of $2.2 billion each year to corn producers nation-wide.[67]

Production from Alternative Feedstocks

Although non-corn ethanol production is a much smaller percentage of the ethanol production market, it is expanding. Some examples of this expansion include the following ethanol production facilities. High Plains Company, which is the 6th largest ethanol producer in the U.S., uses milo/sorghum for 60% of their feedstock (and 40% corn). Georgia Pacific Paper and Ethanol Facility in Washington produces 7 million gallons of ethanol /yr from a pulping by-product. The Simplot potato processing plants in Idaho use by-products to produce about 4 million gallons of ethanol a year. A California company, Arkenol will be producing ethanol from rice straw. Masada Resources Group is planning the first municipal waste-to-ethanol production plant which will utilize over 150,000 tons of solid waste and up to 215,00 tons of sewage sludge to produce 8 million gallons of ethanol a year in New York. Minnesota Brewing Co. has applied for permits to use brewery by-products for ethanol production at their St. Paul brewery, which could produce 15 million gallons of ethanol a year. Construction for the first cellulosic ethanol facility began in October, 1998. The Jennings, Louisana plant will use bagasse, a by-product from the manufacturing of sugar, and rice hulls as the main feedstocks. The plant is expected to produce approximately 20 million gallons of ethanol a year.[68] The National Renewable Energy Laboratory (NREL) also has plans to build several demonstration/pilot biomass-to-ethanol plants, with wood waste as the major feedstock.

Another source of biomass for ethanol production is energy crops. These are fast growing crops raised specifically for energy use such as ethanol for transportation fuel. Currently, trees such as willow and poplar, and switchgrass are being focused on for energy crops as they are fast growing and require less maintenance, fertilizing, and pesticides.[69] The U.S. Department of Agriculture estimates that approximately 129 million acres of excess cropland, which could be used for energy crops, will be available by 2030. If 40 million of these acres were utilized for energy crops for biofuels it would provide transportation fuel equivalent to over 550 million barrels of oil, per year.[70]

The DOE states that "biomass feedstocks represent one of the largest sustainable resources on earth" as they are produced in large quantities from residues/waste and can be obtained cheaply.[71] Feedstock costs can be up to 75% of the total cost for producing ethanol.[72] For this reason, the use of biomass feedstocks to produce ethanol is considered by many to be the key to producing much lower cost ethanol that can compete with gasoline prices and meet a much higher demand. The DOE estimates that energy crops "will result in ethanol costs under $1.00 per gallon by 2005 and under 70¢ per gallon by 2010". For wastes "with zero feedstock costs (e.g., municipal solid wastes)" the DOE estimates costs "to drop as low as 50¢ per gallon [by 2005] and to 34¢ per gallon by 2010".[73]

Production in Michigan

From the late 80's to mid 90's, Michigan was ranked as one of the top ten states for ethanol consumption. Consumption of ethanol blended with gasoline, averaged 51.8 million gallons per year from 1990-1995.[74] However, ethanol production in Michigan ended 13 years ago so demand has been met solely through imports.

By 1983, two ethanol plants had been established in Michigan, in Litchfield (1.5 million g/yr) and Bronson (.3 million g/yr) and construction was planned for a third plant in Alma (8 million g/yr). All the facilities used a dry milling operation with corn as the feedstock. The Alma plant was financed by a group of farmers and a U.S. Economic Development Administration loan guarantee, but costs exceeded their budget and the plant was never completed. The Litchfield plant was closed after approximately 16 months of operation due to poor plant design and financial problems and was opened again in 1984 for a brief period. The operation at Bronson was relatively small and consequently operating costs were much higher than expected revenues and it was closed in 1986.[75]

Corn is the leading crop in Michigan (acreage planted and value), valued at over 670 million dollars.[76] Approximately 2/3 of Michigan's corn is exported out of state.[77] With instate ethanol production the value of the corn would increase the profits from corn even further.

Interest in establishing new ethanol production facilities in Michigan is currently being led by the Michigan Department of Agriculture. The Montcalm Alliance is working with the Department of Agriculture to begin the planning process for establishing an ethanol production plant in the Gratiot-Montcalm Renaissance Zone in Michigan. This area is a particular focus because within a Renaissance Zone nearly all state and local taxes are waived for 15 years, and corn is a major agricultural product in this region. These exemptions would be equivalent to most tax incentives and exemptions for ethanol production offered in other states. The plant will most likely be a 15 or 30 million gallon per year operation and would be organized as a farmer based co-op or limited partnership. It is argued by some that a 30 million gallon plant is more efficient, but of course it requires a much larger initial investment. If an ethanol plant is successfully established in Michigan it is estimated that, "more than $88 million [dollars] will be added to the Michigan economy each year".[78]

Ethanol Production Summary

Ethanol production has several economic impacts including: lower animal feed costs; new jobs; and additional local and state revenues.[79] As alternative feedstocks such as biomass and energy crops become increasingly utilized for ethanol production, the cost of producing ethanol will continue to decrease and enable ethanol to compete with gasoline prices as well as meet higher demands.

Environmental Impact of Ethanol v. Gasoline

In general, alternative fuels such as ethanol are cleaner burning fuels, since they are organic compounds and chemically less complex than other gasoline and diesel fuels. Because they are less complex, when alternative fuels are burned they do not leave as many residues which make up polluting emissions. The Renewable Fuels Association recently wrote that ethanol "is one of the best tools we have to fight urban air pollution" because it burns much cleaner then gasoline and reduces most exhaust emissions.[80]

The Clean Air Act and Amendments require the EPA to monitor U.S. air quality and establish National Ambient Air Quality Standards (NAAQS). If an area of the country exceeds these standards for any of six "criteria pollutants" they are designated as being in nonattainment for that pollutant. The six criteria pollutants are: carbon monoxide, ozone, particulate matter, nitrogen oxides, lead, and sulfur dioxide. Nonattainment is broken down into 5 categories: marginal, moderate, serious, severe, and extreme. Some of the criteria pollutants have been linked to causing minor health problems such as coughing and shortness of breath, to more serious health problems and even death. Health care costs linked to air pollution were estimated by the Clean Fuel Development Coalition to be 45 billion dollars.[81] The use of ethanol to reduce the amount of five of the six criteria pollutants (carbon monoxide, ozone, particulate matter, nitrogen oxides, and lead) is addressed below. Carbon dioxide and aldehyde emissions are also discussed.

Carbon Monoxide (CO)

Carbon monoxide is a poisonous gas and is the leading source of air pollution in the United States. High levels of CO can cause nausea, headaches, serious health problems, and even death. Over 65% of CO emissions are due to transportation. The use of ethanol can reduce CO emissions by up to 30%.[82]

The Clean Air Act Amendments of 1990 mandated the use of oxygenated fuels in areas that do not meet carbon monoxide attainment standards during the winter months, as this is when CO emissions are the highest. As a result, 39 areas are required to use oxygenated fuels. Ethanol and MTBE are the most commonly used fuel additives for oxygenated fuels.[83]

Ozone

Ground-level ozone is the main cause of smog and can result in eye irritation, coughing, shortness of breath, and other respiratory problems. It can also cause significant damage to plants, reducing crop yields.[84] "The EPA considers ozone to be the most widespread air pollution problem".[85]

In 1995, almost 100 cities were in nonattainment of the NAAQS for ozone levels. Over 30% of ozone emissions can be attributed to motor vehicles. To decrease emissions, the use of reformulated gasoline is required in nine areas of the U.S. which have the most serious ozone pollution problems.[86] Ethanol can be used for reformulated gasoline to achieve the required reduction in ozone-forming emissions.

Particulate Matter

Particulate matter is a result of the incomplete combustion of fuel. It can affect breathing and may exasperate existing respiratory and cardiovascular problems, and cause other serious health problems. By using ethanol-blended fuel instead of gasoline particulate tailpipe emissions will be significantly reduced.[87]

Nitrogen Oxides

Nitrogen oxides contribute to ground level ozone, global warming, and acid rain.[88] Approximately 27% of Nitrogen Oxides emissions in the U.S. are from cars and light-duty trucks using gasoline.[89] The use of E-85 reduces the amount of nitrogen oxide emissions by 10%.[90]

Lead

The 1978 Clean Air Act Amendment resulted in the EPA adding lead to its list of criteria pollutants. Standards for lead resulted in the reduction and eventual elimination of lead as an additive for octane enhancement in gasoline. This opened up the market to new octane enhancement products including ethanol. The National Corn Growers Association estimated in 1990 that "ethanol displaces the octane equivalent of 4 billion grams of harmful lead components in gasoline".[91]

Aldehydes

Oxygenated gasoline (including that made with ethanol) has higher aldehyde emissions than gasoline. The primary component of aldehyde emissions from ethanol is acetaldehyde which is toxic and possibly a carcinogen. However, with improved exhaust systems, vehicles manufactured after 1987 reduce the emissions to approximately that of gasoline. "The Royal Society of Canada termed the possibility of negative health effects [from the emissions] ... as being remote".[92]

Carbon Dioxide (CO_2)

Carbon dioxide is a byproduct of burning fuels. It is not toxic but it does contribute to global warming. Motor vehicles account for 30% of CO_2 emissions.[93] Although the use of ethanol in vehicles also results in the release of CO_2, the plants that are grown to produce ethanol absorb at least as much carbon dioxide as is released during ethanol production and use. The Corn Marketing Program states that "the amount of CO_2 released by burning one gallon of ethanol is equal to the amount of CO_2 absorbed by the corn grown to make one gallon of ethanol".[94] Therefore, the net amount of carbon dioxide does not increase as it does through fossil fuel use.[95] In fact, a study by Natural Resources Canada has determined that in Ontario, due to the technology used, corn to ethanol production resulted in a 100% reduction in net carbon dioxide emissions.[96]

In Michigan

Currently two counties in Michigan (Muskegon and Allegan) are classified as non-attainment areas for ozone. However, the EPA has issued a new standard for ozone attainment called the "8 hour standard" and using this standard, new non-attainment areas will begin to be identified in July, 2000. Many areas in Michigan will most likely not meet this new standard and will be classified as non-attainment areas for ozone.[97]

Although portions of Oakland, Macomb and Wayne counties are currently classified as non-attainment areas for CO, the state has petitioned the EPA to reclassify the areas to attainment.[98]

Although Michigan doesn't have as serious of a problem with non-attainment status as many other states, the use of ethanol blended fuel can still contribute to the improvement of air quality and better health and quality of life for residents in its urban areas. Additionally, use of E-10 and E-85 can be targeted for areas in Michigan that are at higher risk for air pollution.

Environmental Impact Summary

Using ethanol blended fuel can reduce carbon dioxide emissions and 5 of the 6 criteria pollutants monitored by the EPA. Reduction of these pollutants are important as they contribute to smog, acid rain, global warming, and health problems.

Stakeholders

Automobile Manufacturers

In 1985 Ford manufactured the first E-85 vehicle. Since then the auto manufacturers have developed flexible fuel technology which allows vehicles to be fueled with either E-85, unleaded gasoline, or any combination of the two. In 1996, Ford released a flexible fueled Taurus and introduced a Ranger truck in model year 1999. Ford manufactured 100,000 E-85 flexible fuel trucks in 1998 and project the same for 1999.[99] In 1998, Chrysler manufactured over 150,000 E-85 vehicles and introduced three types of flexible fuel minivans -the Plymouth, Grand Voyager, and Chrysler Town and Country. Chrysler projects manufacturing approximately the same number of E-85 vehicles in 1999.[100] General Motors has also shown it's support of ethanol fueled vehicles by donating Chevy Malibu's to 14 schools for participation in the 1998 National Ethanol Vehicle Challenge and Silverado trucks for the 1999 Challenge. Students re-engineer the vehicles to run on E-85.

Auto companies have also been supportive of the reformulated gasoline program by running tests and offering technical support. Also, as previously stated, all major automobile manufacturers approve the use of ethanol blends of 10% or less in their vehicles.[101]

Federal Government

The federal government has several areas of involvement in the ethanol field. These include research and development, technological transfer and demonstrations, and as a major user of vehicles and fuels. The most prominent initiatives are through the Department of Energy's Regional Biomass Energy Program, Clean Cities Program and the National Renewable Energy Laboratory.

Regional Biomass Energy Program

The main goal of this program is to increase the use of renewable biofuels. To accomplishing this goal the program supports commercialization of efficient production technologies, education, and market development of ethanol. The five regions that make up the Regional Biomass Energy Program are the Northwest, Western, Great Lakes, Southeast, and Northeast.

Clean Cities Program

The Clean Cities Program is designed to form partnerships between government, industry, and local organizations which encourage and expand the use of alternative fuels and vehicles. The primary goals of this U.S. DOE program are to improve air quality, reduce dependence on imported fuel and provide alternative choices to gasoline and diesel fuel.

The program objectives are:

1. To increase production and use of alternative fueled vehicles (AFV);
2. To expand refueling infrastructure for service and maintenance of AFVs;
3. To advance the objectives of the Clean Air Act and increase the use of cleaner burning fuels; and
4. Advance public understanding of the benefits of AFVs.

In Michigan, the Detroit Metro was the first designated Clean City and encompasses the following seven counties: Livingston,

Monroe, Macomb, Oakland, Washtenaw, Wayne, and St. Clair. Designation means that Detroit is eligible to apply for DOE grants and other special resources to help support their clean cities program. The City of Ann Arbor was designated as a Clean City in April, 1999. The Lansing Tri-County area (includes Ingham, Clinton, and Eaton counties), and the West Michigan Shoreline Regional Development Commission (includes Lake, Mason, Oceana, Newago, and Muskegon counties) have submitted plans to the DOE to be designated as Clean Cities. Additionally West Michigan Regional Planning Commission and Southcentral Michigan Planning Council have just begun the process towards designation.[102]

National Renewable Energy Laboratory (NREL)

NREL conducts ethanol related research, performs emissions testing, and operates the Alternative Fuels Data Center (provides general information on alternative fuels and vehicles) and the Biofuels Information Center (provides technical biofuel conversion information). One of the most important contributions NREL has made to the ethanol production industry is improved bacteria strains for fermenting biomass to ethanol. These strains increase the amount of ethanol that can be produced from biomass and lower the cost of ethanol.

Governor's Ethanol Coalition (GEC)

GEC is a organization of governors from 21 states devoted to increasing production and use of ethanol. The coalition has created the National Ethanol Research Institute, and provided information and testimony to the EPA and Congress. GEC has also formed partnerships with the National Ethanol Vehicle Coalition and National Corn Growers to increase the number of E-85 refueling sites in the U.S., and recently announced that a total of 132 E-85 refueling sites should be operational by the end of 1999.[103]

Corn Marketing Program of Michigan (CMP)

The CMP oversees the corn checkoff program in Michigan. The program sets aside 1¢ per bushel of corn for promotion and research on corn value added products. Because 99% of U.S. ethanol production is from corn, growers have a special interest in the development of the ethanol industry. To encourage the increased use of ethanol the CMP is providing financial assistance for the placement of E-85 refueling stations within the state. They have actively encouraged refueling of federal, state, and private E-85 vehicles with E-85 to support the two current E-85 refueling sites in Detroit and Lansing.

Michigan Ethanol Distributors

Knight Enterprises, Peerless Distributors, Total Petroleum, and Mooney Oil, are some of the distributors in Michigan that supply ethanol.[104]

Universities

Michigan universities such as, Wayne State University (WSU), Kettering University, and Central Michigan University (CMU) are exploring ethanol's possibilities. In addition to their current Automotive Research Center, WSU hopes to establish a Renewable Fuels Research Center to focus efforts on renewable fuels such as ethanol. WSU and Kettering University also participated in the 1998 and 1999 National Ethanol Vehicle Challenge. In the 1998 Challenge Wayne State won first place for their ethanol converted vehicle and Kettering won "best emissions". In the 1999 Challenge Kettering won third place and "best off-road handling" and Wayne State

won fifth place and "lowest emissions". Research is also currently being conducted at CMU on optimizing the conversion of wet and pressed sugar beet pulp into ethanol.

State Government

To develop a state AFV plan as required by EPAct, a task force consisting of representatives from 8 state departments analyzed a number of relevant issues in Michigan. The task force recommended a long-term policy of fuel neutrality, letting the market determine what fuels should be used, while insuring that no regulatory or market barriers stand or are introduced that inhibit the development of the alternative fuel industry. The task force also recommended that the State's short-term goals should be: (1) increasing alternative fuel education; (2) instituting policies to reduce alternative fuel market barriers; and (3) providing temporary incentives for AFV purchases, fueling infrastructure and in-state production.[105]

The Department of Consumer and Industry Services, Energy Resources Division (ERD) and the Department of Agriculture are actively involved in alternative fuel education, expanding the alternative fuel infrastructure, and supporting the establishment of in-state ethanol production.

ERD facilitates DOE's Clean Cities Program, designed to increase the use of alternative fuels and vehicles, by providing grants and project assistance to local coalitions (20 counties). ERD's Biomass Energy Program is currently focusing on ethanol issues which are consistent with the program's mission to encourage increased production and/or use of energy derived from biomass resources. The program has compiled this paper due to the lack of comprehensive information on ethanol which address ethanol markets, production, environmental impacts, and Michigan specific information.

The Department of Agriculture is the lead agency representing Michigan in the Governor's Ethanol Coalition and is working with others in establishing an ethanol production facility in Michigan.

Concluding Remarks

Increasing the use and production of ethanol will increase U.S. and state income and employment, decrease dependency on foreign oil, retain more dollars in the local community, and reduce most vehicle emissions. The value added to corn due to ethanol production is especially important in Michigan, as corn is the leading crop (acreage planted and value), and the state was ranked 6th in the U.S. for corn production in 1998.[106]

The potential for Michigan's economy to benefit from developments in ethanol can be tapped by addressing both consumption and production of ethanol.

State ethanol consumption

First ethanol demand needs to increase enough to support in-state ethanol production. Through encouraging the use of E-10 demand can be greatly increased without any change in the current refueling infrastructure. Some possible strategies for increasing the use of E-10 are: 1) Remove the ethanol labeling requirement in Michigan which may discourage consumers from purchasing the fuel; or 2) Require the labeling of all additives in gasoline and the safety hazards associated with them so fair comparisons to ethanol can be made; and/or 3) Launch an education campaign to educate consumers on the facts about E-10 to counteract the stereotypes formed in the 80's; and 4) Target E-10 marketing to areas of Michigan currently in non-attainment of ozone or carbon dioxide air quality standards, or areas at risk for non-attainment.

Demand for ethanol can also be increased by expanding the public E-85 refueling infrastructure to accommodate the growing number of E-85 vehicles operating in Michigan and by targeting state fleet vehicles to specific areas to support current and new E-85 refueling sites. To determine where additional refueling sites should be sited, a study on vehicle travel could be done with selected fleets or individual owners. The state and federal fleets have a login register for each vehicle which could be used to pull data on direction and amount of travel. Data on the location of E-85 vehicles in Michigan is available from the Secretary of State.

To insure that E-85 vehicles are being fueled with ethanol instead of gasoline and that current refueling sites are utilized, drivers need to be educated about ethanol and where current E-85 sites are located. In the recent study conducted by the Governors' Ethanol Coalition, "Drivers Awareness, Attitudes &Usage Of Ethanol-Blended Fuel", it was found that the two most important messages to convince drivers to use ethanol are: 1) that it reduces emissions and improves air quality and, 2) that it's safe to use and it won't harm their engine.[107]

Additionally, incentives could be used to encourage the refueling of E-85 vehicles with ethanol. For example, Illinois has placed coupons in state E-85 vehicles for drivers to receive a free beverage at E-85 stations. The coupons not only encourage driver's to refuel at E-85 stations, they also make them aware of where the stations are located for future refueling. In June, 1999

Ford introduced a similar program to encourage the use of E-85 in their flexible fuel vehicles. Consumers in Chicago, Minneapolis, and St. Paul area who purchase Ford E-85 pickup trucks and live within 15 miles of an E-85 station will be mailed 8 coupons for $5 off the purchase of E-85 fuel and maps with the location of all the current E-85 stations.[108]

State ethanol production

Once demand for ethanol in Michigan is at a level to support in-state production, the establishment and success of ethanol production facilities is much more likely. The conditions for local production are currently more favorable, given the extension of the ethanol federal tax incentive program until 2007.

The establishment of new state based incentives may also speed up the establishment of ethanol facilities in Michigan. A re-introduction of the producer credit that existed in the early 80's could attract investment in ethanol production in Michigan and if the demand is sufficient to support production the plants will be able to maintain profits and stay in business. The case of ethanol production in Minnesota is an example. Minnesota has a 10 year 20¢ per gallon producer payment, has 15 ethanol production facilities, and the state's economy is realizing a return of $10 - $16 for every dollar of producer payment made by the state.

In the Midwest, it appears that many citizens support the idea of using state revenues (through tax exemptions and incentives) to further the development of fuels such as ethanol. In 1997, the Governors' Ethanol Coalition conducted a study with focus groups and 750 telephone interviews throughout the Midwest to determine drivers' acceptance of ethanol blended gasoline. Results show that 50% of the drivers agree that the government should target subsidies towards the development of domestically produced fuels.[109]

If the establishment of new ethanol production facilities is focused in state-designated Renaissance Zones in Michigan where new businesses are exempt from virtually all state and local taxes it would be nearly equivalent to ethanol production tax incentives and exemptions given in other states. Coupled with the federal incentives such an undertaking could be economic in Michigan.

Recommendations

State departments should continue to take an active role in supporting education, infrastructure development, and in-state ethanol production. In the near-term, potential consumers should be educated on the availability and benefits of ethanol and encouraged to utilize existing refueling sites. Longer-term efforts can focus on a plan to develop the state's capacity for ethanol production. It also appears to be an opportune time for the state to create an ethanol taskforce to further study and implement these and other recommendations.

The Michigan Biomass Energy Program can play a key role in both the short-term and long-term efforts by providing support to projects that encourage ethanol production and consumption in Michigan and by continuing to disseminate ethanol information.

Notes

1. National Ethanol Vehicle Coalition (NEVC), The Future Fuel is Now.

2. Renewable Fuels Association (RFA), Less Pollution, p.2.

3. United States, Department of Energy (DOE), "Why Biofuels: Sustainable Transportation Systems", p.3.

4. State of Michigan, Alternative Fueled Vehicle Inter-Departmental Task Force, Michigan State Plan for Alternative Fueled Vehicles, p.2.

5. State of Michigan, Department of Management and Budget, Alternative Fuel Vehicle Acquisition Activity.

6. State of Michigan, Department of State, Selected Vehicle Registration Records.

7. David Morris, Ethanol: A 150 Year Struggle Toward a Renewable Future, p.1.

8. United States, DOE, History of Biofuels, p.1.

9. Morris, Ethanol: A 150 Year, p.1

10. Ibid, p.3

11. State of Michigan, Department of Agriculture, et al. Alcohol Fuels in Michigan, p.3.

12. United States, General Accounting Office (GAO), Tax Policy: Effects of the Alcohol Fuels Tax Incentives, p.32.

13. United States, Editorial and Special Issues Department, Government Activity Benefitting Domestic Ethanol Industry.

14. United States, GAO, Tax Policy..., p.33.

15. RFA, "Ethanol: 20 Years on the Road", p.4.

16. United States, Editorial and Special Issues Department, Government Activity..., p.1.

17. State of Michigan, Department of Agriculture, Alcohol Fuels...

18. United States, GAO, Tax Policy..., p.33.

19. United States, Editorial and Special Issues Department, Government Activity..., p.2.

20. Clean Fuels Development Coalition(CFDC), Clean Fuels: Paving the Way for America's Future, p.6.

21. United States, GAO, Tax Policy..., p.33.

22. RFA, "Ethanol: 20 Years...", p.4.

23. United States, DOE, State Alternative Fuel Laws and Incentives.

24. Corn Marketing Program (CMP) of Michigan, Ethanol: Helping to Fuel the American Economy.

25. CFDC, pp.44-46.

26. CMP, Ethanol...

27. Jerry Roussel, Ford Motor Company, Personal communication.

28. RFA, “Congress Votes to Extend Tax Incentive”, p.1.

29. Morris, Ethanol: A 150 Year, pp.1-3.

30. United States, Environmental Protection Agency, MTBE Fact Sheet #3: Use and Distribution of MTBE and Ethanol.

31. Fuels for the Future, Methanol Dangers are Cited as U.S. Incidents Increase.

32. RFA, “Congress Votes...”, p.1.

33. RFA, “UC-Davis Releases Health & Environmental Assessment of MTBE”, p.1.

34. CNN, EPA urges less use of smog-fighting gas additive because of cancer risk, p.2.

35. RFA, “Senate Approves Resolution Promoting Ethanol as MTBE is Phased-out”, p.1.

36. State of Michigan, Department of Agriculture, Alcohol Fuels..., p.27.

37. National Corn Growers Association (NCGA), Ethanol: A Clean Breeze Across America.

38. Ethanol Producers and Consumers (EPAC), Ethanol Producers and Consumers.

39. State of Michigan, Department of Agriculture, Alcohol Fuels...

40. State of Michigan, Department of Consumer and Industry Services, Michigan Energy Appraisal: Semiannual Projections of Energy Supply and Demand Summer Outlook 1998, p.10.

41. State of Michigan, Department of Agriculture, Alcohol Fuels..., p.23.

42. United States, DOE, Alternatives to Traditional Transportation Fuels: An Overview, pp.84-85.

43. Mike Clement, Chrysler Corporation, Personal communication.

44. CFDC.

45. Scott Benson, General Services Administration, Personal Interview; William Perry, Michigan Department of Management and Budget, Personal communication.

46. Peter Porciello, Michigan Department of Transportation, Personal communication.

47. United States, GAO, Tax Policy..., p.51.

48. United States, DOE, Alternatives to..., p.66.

49. Hart Publications Inc., “Ethanol, MTBE Production Volumes Strong in 1997”, p.8.

50. RFA, “U.S. Ethanol Production Tops All Time High”, p.1.

51. Bryan & Bryan, U.S. Ethanol Plants: In production and under construction.

52. RFA, Ethanol: Fueling America’s Future Today.

53. NEVC, E85: Fueling the...

54. CFDC, p.11.

55. CMP, Ethanol...

56. Michael Evans, The Economic Impact of the Demand for Ethanol, p.2.

57. RFA, "U.S. Ethanol...", p.1.

58. United States, GAO, Tax Policy...

59. United States, DOE, State Alternative Fuel Laws...; United States, DOE, 1997-98 Tax Guide for Alternative Fuels.

60. HART/IRI Fuels Information Services and ARCO Chemical, 1994 United States Fuel Reformulation Map.

61. Ibid.

62. NCGA, The World of Corn, p.8.

63. Ibid, p.18.

64. Ibid, p.18.

65. NEVC, E85: Fueling the...

66. RFA, Agriculture, p.1.

67. RFA, Ethanol: Fueling America's...

68. Bryan & Bryan, The Energy Independent. Nov./Dec. 1998; The Energy Independent, January, 1999.

69. United States, DOE, "Moving Biofuels into the Mainstream: Where We Stand", p.2.

70. United States, DOE, "Moving Biofuels from Research to Market: The Major Issues", p.3.

71. United States, DOE, Bioethanol from the Corn Industry.

72. S. Becker, et al, The Availability of Waste Sugar Products as an Alternative Feedstock for the Production of Ethanol.

73. United States, DOE, "Moving Biofuels into the Mainstream...", p.3.

74. United States, DOE, 1995 State Energy Data Report: Consumption Estimates, p.165.

75. State of Michigan, Department of Agriculture, Alcohol Fuels..., pp.5-6.

76. State of Michigan, Department of Agriculture, 1997-98 Michigan Agricultural Statistics.

77. Dale Sherwin, Michigan Department of Agriculture, Personal communication.

78. CMP, Ethanol...

79. Evans.

80. RFA, Ethanol: Fueling America's...

81. CFDC, p.1.

82. United States, DOE, Argonne National Laboratory, Student Competitions: Using Ethanol as a Vehicle Fuel, p.1.

83. CFDC, p.5.

84. CMP, Use Ethanol Blended Gasoline Today...Breathe Easier Tomorrow; GreenFuels, Environmental Effects of Ethanol and Gasoline, p.1.

85. RFA, Ethanol: Fueling America's...

86. CFDC, pp.5-6.

87. RFA, Less Pollution, p.1.

88. State of Michigan, Department of Environmental Quality (DEQ), 1995 Air Quality Report.

89. CFDC, p.4.

90. State of Michigan, Alt. Fuel Task Force, Michigan State Plan...,p.14.

91. NCGA, Ethanol: A Clean Breeze...

92. GreenFuels, How Does Ethanol..., p.2.

93. State of Michigan, Alt. Fuel Task Force, Michigan State Plan..., p.13.

94. CMP, Use Ethanol Blended Gasoline...

95. NEVC, The Future Fuel...

96. GreenFuels, Just How Environmentally Friendly is Ethanol, p.2.

97. Robert Rusch, DEQ, Personal communication; State of Michigan, DEQ, Ozone Attainment Areas.

98. Rusch; State of Michigan, DEQ, Carbon Monoxide Attainment Areas.

99. Ford Company.

100. Clement.

101. CFDC, pp.44-46.

102. Tim Shireman, Michigan Dept. of Consumer and Industry Services, Personal communication.

103. Governors' Ethanol Coalition (GEC), http://www.ethanol-gec.org, 1998.

104. Keith Muxlow, Corn Marketing Program of Michigan, Personal interview.

105. State of Michigan, Alt. Fuel Task Force, Michigan State Plan..., pp.32-33.

106. State of Michigan, Deptartment of Agriculture, 1997-98 Michigan Agricultural Statistics.

107. GEC, Drivers Awareness, Attitudes and Usage of Ethanol Blended Fuel: Research Summary Report, p.1.

108. RFA, "Ford Coupon Program to Encourage Use of E85", p.3.

109. GEC, Drivers Awareness...,p.7.

References

Becker, S., et al. The Availability of Waste Sugar Products as an Alternative Feedstock for the Production of Ethanol. Southern Illinois University, College of Agriculture, 1997.

Benson, Scott. General Services Administration (GSA). Personal Interview. March 2, 1998.

Bryan & Bryan. U.S. Ethanol Plants: In production and under construction. Cotopaxi: Bryan & Bryan Inc., 1998.
---. The Energy Independent. Nov./Dec. 1998.
---. The Energy Independent. January, 1999.

Clean Fuels Development Coalition (CFDC). Clean Fuels: Paving the Way for America's Future. Bethesda: CFDC, 1995.

Clement, Mike. Chrysler Corporation. Personal communication. December, 1998.

CNN. EPA urges less use of smog-fighting gas additive because of cancer risk. Available: http://cnn.com/NATURE/9907/27/PM-CleanGasoline.ap/index.html, 29 August 1999.

Corn Marketing Program (CMP) of Michigan. Ethanol: Helping to Fuel the American Economy. Lansing: CMP, 1996.
---. Use Ethanol Blended Gasoline Today...Breathe Easier Tomorrow. Lansing: CMP, 1997.

Ethanol Producers and Consumers (EPAC). Ethanol Producers and Consumers. Nashua: EPAC.

Evans, Michael K. The Economic Impact of the Demand for Ethanol. Lombard: Midwestern Governor's Conference, 1997.

Ford Company. Alternative Fuel Hotline (1-800-ALT-FUEL). Personal communication. 1998.

Fuels for the Future. Methanol Dangers are Cited as U.S. Incidents Increase. Washington: Fuels for the Future, 1994.

Governors' Ethanol Coalition. Drivers Awareness, Attitudes and Usage of Ethanol Blended. Cevette and Company, 1997.
---. Governors' Ethanol Coalition (GEC), http://www.ethanol-gec.org, 1998.

GreenFuels. Just how Environmentally Friendly is Ethanol. Available: http://www.greenfuel.org/ethaenv2.html, 1998.
---. How Does Ethanol "Clear the Air"? Available: http://www.greenfuels.org/ethaair.html, 1998.
---. Environmental Effects of Ethanol and Gasoline. Available: http://www.greenfuels.org/ethaenv1.html, 1998.

HART/IRI Fuels Information Services & ARCO Chemical. 1994 United States Fuel Reformulation Map. Potomac: HART,1994.
Hart Publications, Inc. "Ethanol, MTBE Production Volumes Strong in 1997." Oxy-Fuel News February 9, 1998.

Morris, David. Ethanol: A 150 Year Struggle Toward a Renewable Future. Washington: Institute for Local Self-Reliance, 1993.

Muxlow, Keith. Corn Marketing Program of Michigan. Personal interview. April 23, 1998.

National Corn Growers Association (NCGA). Ethanol: A Clean Breeze Across America. St. Louis: NCGA, 1990.
---.The World of Corn. St. Louis: NCGA,1998.

National Ethanol Vehicle Coalition (NEVC). E85: Fueling the Future Today. Jefferson City: NEVC, 1998.
---. The Future Fuel is Now. Jefferson City: NEVC, 1998.

Perry, William. Michigan Department of Management and Budget. Personal communication. January, 1999.

Porciello, Peter. Michigan Department of Transportation. Personal communication. 1998.

Renewable Fuels Association (RFA). Ethanol: Fueling America's Future, Today. Washington: RFA,1998.
---. "Congress Votes to Extend Tax Incentive". Ethanol Report May 25, 1998.
---. "Ethanol: 20 Years on the Road". Ethanol Report July 2, 1998.
---. "UC-Davis Releases Health & Environmental Assessment of MTBE". Ethanol Report November 12, 1998.
---. "Ford Coupon Program to Encourage Use of E85". Ethanol Report June 3, 1999.

---. Less Pollution. Available: http://www.ethanolrfa.org/rfa5.html. 19 January 1999.
---. Agriculture. Available: http://www.ethanolrfa.org/rfa2.html. 19 January 1999.
---. Press Release: "U.S. Ethanol Production Tops All Time High". December 1, 1998. Available: http://www.ethanolrfa.org/pr120198.html. 19 January 1999.
---. "Senate Approves Resolution Promoting Ethanol as MTBE is Phased-out". Ethanol Report August 26, 1999.

Rusch, Robert. Michigan Department of Environmental Quality. Personal communication. March 18, 1999.

Roussel, Jerry. Ford Motor Company, Alternative Fuels Program. Personal communication. March, 1999.

Sherwin, Dale. Michigan Department of Agriculture, Director of Agriculture Policy. Personal communication. 1999.

Shireman, Tim. Michigan Department of Consumer and Industry Services, ERD. Personal communication. 1998.

State of Michigan. Department of Agriculture, et al. Alcohol Fuels in Michigan. Lansing, 1983.

State of Michigan. Department of Agriculture. 1997-98 Michigan Agricultural Statistics. Available: http://www.mda.state.mi.us/mass/stats98/crops.htm. 19 January, 1999.

State of Michigan. Alternative Fueled Vehicle Inter-Departmental Task Force. Michigan State Plan for Alternative Fueled Vehicles. Lansing, 1996.

State of Michigan. Department of Consumer and Industry Services. Michigan Energy Appraisal: Semiannual Projections of Energy Supply and Demand Summer Outlook 1998. Lansing: Public Service Commission, 1998.

State of Michigan. Department of Environmental Quality (DEQ). 1995 Air Quality Report. Lansing: Air Quality Division, 1996
---. Ozone Attainment Areas. July 23, 1998. Available: http://www.deq.state.mi.us. 1 December, 1998.
---. Carbon Monoxide Attainment Areas. July 23, 1998. Available: http://www.deq.state.mi.us. 1 December, 1998.

State of Michigan. Department of Management and Budget. Alternative Fuel Vehicle Acquisition Activity. Lansing: 1999.

State of Michigan. Department of State. Selected Vehicle Registration Records. Lansing: Bureau of Information Systems, 1998

United States. Department of Energy. State Alternative Fuel Laws and Incentives. Washington: Office of Energy Efficiency and Renewable Energy, 1994.
---. Alternatives to Traditional Transportation Fuels: An Overview. Publication DOE/EIA-0585/O. Washington: Energy Information Administration, 1994.
---. "Why Biofuels: Sustainable Transportation Systems". DOE Strategic Plan 1996 Available: http://www.esd.ornl.gov/bfdp/doeofd/stratpla/ybiofuel.html. 28 January 1998.
---. "Moving Biofuels into the Mainstream: Where We Stand". DOE Strategic Plan 1996 Available: http://www.esd.ornl.gov/bfdp/doeofd/stratpla/stand.html. 28 January 1998.
---. "Moving Biofuels from Research to Market: The Major Issues". DOE Strategic Plan. 1996 Available: http://www.esd.ornl.gov/bfdp/doeofd/stratpla/issues.html. 28 January 1998.
---. 1997-98 Tax Guide for Alternative Fuels.1998 Available: http://www.afdc.doe.gov/taxes/1998/fed-tax.html.27 Jan.1999.
---. 1995 State Energy Data Report: Consumption Estimates. Publication DOE/EIA-0214(95). Washington: Energy Information Administration, 1997.
---. Bioethanol from the Corn Industry. Publication DOE/GO-10097-577 Golden: National Renewable Energy Laboratory, 1998.
---. History of Biofuels. Available: http://www.ott.doe.gov/biofuels/history.html. 29 April 1999.
---. Student Competitions: Using Ethanol as a Vehicle Fuel. Argonne National Laboratory, Available: http://www.transportation.anl.gov. September, 1999.

United States. Environmental Protection Agency. MTBE Fact Sheet #3: Use and Distribution of MTBE and Ethanol. Publication EPA 510-F-97-016. Office of Solid Waste and Emergency Response: 1998.

United States. Editorial and Special Issues Department. Government Activity Benefitting Domestic Ethanol Industry. Public Affairs Group: 1996.

United States. General Accounting Office. Tax Policy: Effects of the Alcohol Fuels Tax Incentives. Publication GAO/GGD 97-41. Gaithersburg: GAO, 1997.